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FUNCTIONAL FORM AND THE DEMAND FOR RURAL DEPOSITS IN BANGLADESH

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ABSTRACT

The paper uses the Bangladesh district data to determine the functional form of the demand for rural deposits through the Box-Cox transformation. The results show that the Box-Cox form generates better results. Linear and log-linear functional forms are rejected.

Biographical Sketch

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INTRODUCTION

Two functional forms - linear and log linear - are popularly used in research on demand for rural deposits in developing countries. These forms are chosen frequently not because they are expected to be superior to non-linear forms, but because of statistical convenience, ease in estimation and easier estimation of elasticities. The arbitrary use of the linear function may lead to biased and inconsistent estimates and to specification errors (Kmenta; Murty and Murty; Zarembka). Thus, it is necessary to test for the appropriate functional form when studying demand for deposits.

The objective of this paper is to summarize the results of research on the functional form of demand for rural deposits in Bangladesh, i.e., to test whether the function is linear or double-log linear. The analysis uses the Box-Cox parametric transformation in which the linear and double-log are special cases. This transformation has the advantage of determining the most appropriate functional form by maximizing the likelihood function, and can be referred to as the General Functional Form (GFF). Zarembka argues that the GFF does not differentiate between linear and double-log linear functional forms, but has the advantage of simple estimation procedures. The Box-Cox transformation has been widely used in various types of economic studies (for example, Burndt and Khaled; Chang; Chern and Soheron-Ferror; Zarembka).

THE DEMAND FOR RURAL DEPOSITS FUNCTION

Like any other demand function, the household demand for rural deposits function is expressed as:

$D_i = f(Y, DIR, P_{oi})$ . . . . (1)

where D_i refers to interest-bearing deposits, Y is income, and DIR and P_{oi} represent price of deposits, and prices of other substitutes and complementary goods, respectively. The interest rate paid on deposits is the explicit price. Related to this are implicit and real prices. Implicit prices may include free checking services, gifts etc. The real price is the explicit price less transaction costs. Because of the unavailability of data on transaction costs, most authors are forced to use proxies such as number of bank branches, and an index of roads and transport (Burkett and Vogel; Khalily, Meyer and Hushak; Srinivasan and Meyer). These studies have found a positive relationship between deposit rates and interest bearing deposits. However, debate remains over the direction of the effects of interest rates. Lanyi and Saracoglu, evaluating the available evidence in Asian countries, suggested that the substitution effect of interest rate changes is more important than income effects.

Physical assets and other forms of financial instruments represent competing goods. Ortmeyer found that a higher return on physical assets contributes negatively to the demand for financial assets by households. Similarly, Gupta found deposits to be substitutes for government financial instruments. But because of the lack of organized data on rural investments, most studies of demand for deposits exclude the prices of other commodities as variables. This creates a problem to test for homogeneity and symmetry conditions.

Income has a profound influence on interest deposits. The higher the income of rural households, the greater will be their ability to demand interest bearing deposits. Because of the variability of rural household income, the "permanent income" hypothesis may offer a better explanation of the influence of income on interest bearing deposits than does the "absolute income" hypothesis (Khalily, Meyer and Hushak). In this paper, the "permanent income" hypothesis is used. The coefficient of transitory income is expected to be larger than the coefficient for the permanent income variable.

In the light of the above, the demand function for rural deposits is redefined as:

$$D_i = f\ (RTI,\ BBR,\ DIR,\ PY,\ TY)\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ (2)$$

where, BBR and RTI are number of rural bank branches and index of roads and vehicles, respectively. PY and TY represent permanent and transitory income.

Most previous studies on rural deposits assumed one-way causality between deposits and bank branches. Khalily et al. showed that a simultaneous relationship exists between bank branches and rural deposits. The degree of simultaneity will depend on the magnitude of competition for deposits. In this paper, however, a single equation approach is used because of the complexity of the simultaneous estimation of the parameters through a Box-Cox transformation. Since the objective is to determine the appropriate functional form, this simplification will not affect the estimation procedure and the consistency and unbiased properties of the estimates.

GENERAL FUNCTIONAL FORM

The demand function in equation (2) is expressed in linear form as:

$$D_i = \beta_0 + \beta_1 RTI + \beta_2 BBR + \beta_3 DIR + \beta_4 PY + \beta_5 TY + \epsilon_i\ .\ .\ (3)$$

The expression in (3) assumes that (a)$E(\epsilon) = 0$; (b) $V(\epsilon) = \sigma^2$; (c)$\epsilon_i \sim N(0,\sigma^2)$; and (d) the observations are independent. Box-Cox argued that if conditions (a) through (c) do not hold, then a non-linear transformation of the original observations will improve the estimation. Furthermore, they argued that a transformation of dependent and independent variables can be applied without affecting constant variances and normality of error distribution.

Considering a general functional form, and following Box-Cox, and Zarembka, eq. (3) can be expressed as:

$$\frac{D(t)^{\lambda}-1}{\lambda} = \beta_0 + \beta_1 \frac{RTI(t)^{\lambda}-1}{\lambda} + \beta_2 \frac{BBR(t)^{\lambda}-1}{\lambda} + \beta_3 \frac{DIR(t)^{\lambda}-1}{\lambda} + \beta_4 \frac{PY(t)^{\lambda}-1}{\lambda} + \beta 5 \frac{TY(t)^{\lambda}-1}{\lambda} + \epsilon_t \quad \ldots\ldots\ldots\ldots (4)$$

where, ϵ_t is the disturbance term, and β_o, β_i, β_2, β_3, β_4 and β_5 are the parameters.

Following the L'Hopital rule, eq.(4) can be rewritten as:

$$D_i(t)^{\lambda} = \beta_o + \beta_1 RTI(t)^{\lambda} + \beta_2 BBR(t)^{\lambda} + \beta_3 DIR(t)^{\lambda} + \beta_4 PY(t)^{\lambda} + \beta_5 TY(t)^{\lambda} + \epsilon_t \quad (5)$$

where λ expresses the transformation of variables.

Eq.(5) allows the elasticities of $D_i(t)$ with respect to income, price of deposits, bank branches, and roads and vehicles to vary with a change in the value of each of the independent variables. Differentiating $D_i(t)$ with respect to RTI, BBR, DIR, PY and TY, it is possible to get marginal coefficients and estimate elasticities (E). Following previous research on rural deposits, $E_{D,PY} > 0$, $E_{D,TY} > 0$, $E_{D,P} > 0$, $E_{D,BB} > 0$ and $E_{D,RD} > 0$ since β_1, β_2, β_3, β_4 and β_5 are expected to be positive. Positive values for β_3 and β_4 imply that reducing transaction costs increases demand for deposits by rural households.

The objective is to find a value of λ such that the likelihood function is maximized. Using the maximum likelihood approach, the likelihood function is expressed as:

$$L^*(\theta / Data) = -\frac{T}{2}\log 2\pi - \frac{T}{2}\log \sigma^2 + (\lambda - 1)\Sigma_t \log D_i(t)$$
$$- \frac{1}{2\sigma^2}\Sigma_t \; D_i(t) - \beta_0 - \beta_1 RTI(t) - \beta_2 BBR(t) - \beta_3 DIR(t) - \beta_4 PY(t) -$$
$$\beta_5 TY(t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

where θ is the vector of parameters. Box-Cox showed that for a given λ, the maximum log likelihood value is:

$$L_{max}(\lambda) = -\frac{T}{2}\log \sigma(\lambda) + (\lambda - 1)\Sigma_t \log D_i(t) \quad \ldots\ldots\ldots\ldots (7)$$

Box-Cox suggested that by using the maximum likelihood ratio, the confidence region of λ can be estimated, which is $2\,[L_{max}(\hat{\lambda}) - L_{max}(\lambda)]$ and has a chi-square distribution with one degree of freedom. Therefore, $(1-\alpha)$ confidence interval for λ can be obtained with the value of λ such that $L_{max}(\hat{\lambda}) - L_{max}(\lambda) < \frac{1}{2} X^2(\alpha)$.

DATA SOURCE

The model in eq.(5) was fitted to pooled district data for 1983 and 1984. Data on income, inflation rates, roads and vehicles were obtained from the Bangladesh Statistical Year Book, 1985. Data on deposits and rural bank branches were collected from the Central Bank Data Tapes for 1983 and 1984.

Income was proxied by district agricultural GDP. The permanent and transitory components of agricultural GDP were estimated from 1976-84 GDP data by regressing GDP on time. Trend values were treated as permanent agricultural GDP. Interest rates on various types of deposits are the same across districts. Therefore, a weighted deposit interest rate (DIR) was calculated through weighting the proportion of each type of deposit to total deposits in each district. Various types of deposits are offered at different interest rates. The variation in the proportion of each type of deposit held represents the differential preference of households regarding types of deposits and interest rates. Assuming that such preferences reflect their response to variations in interest rates on different types of deposits, the weighted interest rate on deposits is expected to capture its effects on demand for interest bearing deposits. Bank branches were measured as number of branches per 10,000 rural inhabitants. The index of district roads and vehicles was constructed as:

$$RD_j = \left[\frac{R_j}{TA_j} \cdot \frac{T_j}{POP}\right] \cdot 100 \quad \dots\dots\dots\dots\dots\dots \quad (7)$$

where RD_j is the weighted index of roads and vehicles in the j^{th} district; R_j is the mileage of roads in j^{th} district; TA_j is the total district geographical area; and T_j is the number of vehicles.

EMPIRICAL RESULTS AND ANALYSIS

Since the Box-Cox transformation was conducted for both the dependent and independent variables by the same Lambda values, the transformation allows for testing of only linear and log-linear functions. When $\lambda = 0$, the function is log-linear. Table 1 shows the maximum log-likelihood values for different λ. The R^2 and the log-likelihood function are maximized at $\lambda = -0.53$. Therefore, the variables were transformed by the Lambda value of -0.53 and the estimates of the parameters were obtained by ordinary least squares. The Goldfeld-Quandt technique was used to test for heteroskedasticity. Heteroskedasticity was rejected since $F < F_{0.95}$ which suggests that error variances are the same across regions and year.

Table 2 shows the estimated regression coefficients under the different values λ = -0.53, λ = 0, and λ = 1. The parameters have the expected signs in all cases, although the R^2 for the Box-Cox general form and the log-log linear is larger than for the linear form. The R-square for the Box-Cox was estimated at 0.818, while it was 0.766 for the log-log linear function.

All variables except DIR are significant at the 5% level in both the Box-Cox general and the log-linear functions. DIR is significant (α = .10) only in the former case. The 'permanent income' hypothesis holds in this study since the coefficient of transitory income is larger than it is for permanent income. Comparing the standard error and the number of significant variables, the Box-Cox general form appears to be superior. But the question arises as to whether or not the functional differences are statistically significant. By using the likelihood ratio, the 95% confidence interval for λ was estimated. λ varies between -.95 and -.15. Since λ = 1 does not fall within this range, the null hypothesis of the linear functional form is rejected. Similarly, the null hypothesis of the log-linear model is rejected because λ = 0 does not fall in the interval. That is, there is significant statistical difference between the Box-Cox general functional form and log-log linear function.

There are no empirical studies or comprehensive theoretical discussion about the possible trends in elasticities for income, interest on deposit rates, roads and vehicle index and expansion of bank branches. But observations in Bangladesh and in other developing countries suggest that there is no one to one correspondence between the dependent and independent variables. It would be logical to expect that deposits will increase at a decreasing rate with a unit change in the independent variables. Specifically, it would be expected that the level of income will determine the degree of demand for interest bearing deposits. Higher income households probably enjoy wider investment opportunities than lower income ones. Therefore, their marginal demand for interest bearing deposits will probably be less. Similarly, because of limited deposit potential in any geographic area, a continuous expansion of banking facilities will eventually lead to a decrease in interest bearing deposits per branch. The effects of interest rates and the roads and vehicle index are expected to be ambiguous over time since they are linked to alternate forms of investments and wider investment opportunities. The trend in elasticities for income and expansion of bank branches are expected to be curvilinear with a concave shape. Development of the Bangladesh rural financial system has been fairly recent and there are still many unbanked areas. Competition is fairly weak among financial institutions; consequently, it is believed that rural deposits in relation to both income and branch expansion are in the increasing part of the curve.

A separate estimate and plot of income and expansion of bank branches elasticities (not shown for limited space) for each district and year showed that the permanent income and bank branch elasticities declined in the following year in all the regions, while it increased for transitory income.

CONCLUSIONS

The regression results satisfactorily explain the expected relationship between the dependent and independent variables, and corroborate the findings of previous research. A fundamental advantage of the Box-Cox form over the log-linear functional form is the pattern in the elasticities. The log-linear form generates a constant elasticity over time which is inconsistent and unrealistic to assume in a dynamic environment. The elasticities in the Box-

Cox form fluctuate depending on the value of λ. In addition, the arbitrary use of log-linear functional form may lead to specification errors and inappropriate results if the functional form does not hold. The use of the Box-Cox general form, in which linear and log-linear are special cases, not only eliminates the probability of specification error but generates a better result.

Three major findings emerge from this study. First, both the linear and log-linear functional forms are statistically rejected for the demand for deposits function. However, the signs of coefficients in both the forms were as expected. Second, the deposit elasticities with respect to income and branch expansion vary over time. Third, the number of significant parameters is higher in the Box-Cox than in the log-linear. In addition, the standard errors are lower for the Box-Cox form. Thus, the Box-Cox general form not only rejects both linear and log-linear functional forms but provides better results.

An important limitation of this study is the short time period for which data are available. A more comprehensive study over a longer period will help test these conclusions. Additional research is also needed on the nature of the relationship between deposits, income and bank branches.

TABLE 1

Estimates of the Log-Likelihood Function
at Different Lambda Value

Lambda	Log - L.F.	R-Square
0.000	-176.698	0.7656
1.000	-201.171	0.5094
-1.000	-175.347	0.8374
-0.764	-173.569	0.8299
-0.618	-173.065	0.8230
-0.562	-172.991	0.8200
-0.541	-172.981	0.8188
-0.533	-172.978	0.8183
-0.530	-172.978	0.8181
-0.528	-172.978	0.8180
-0.527	-172.978	0.8179
-0.525	-172.978	0.8178
-0.520	-172.979	0.8175
-0.507	-172.983	0.8167

TABLE 2

Estimates of Parameters

Model	Independent Variable RTI	BBR	DIR	PY	TY	R^2
λ =-.53	0.0039*	.1048*	.3845**	.01835*	.3229*	.818
	(.000759)	(.01089)	(.2869)	(.01007)	(.1020)	
λ = 0	0.2067*	1.4273*	.8345	.1932**	3.7005*	.766
	(.0402)	(.19401)	(.9318)	(.1405)	(1.1003)	
λ = 1	66.711*	185.26*	1.2789	26.357	411.61*	.509
	(22.715)	(57.865)	(13.121)	(27.052)	(152.91)	

Note: Figures in parenthesis represent standard error
* Significant at .05 level
** Significant at .10 level

TABLE 3

Estimates of Elasticity at Means
Under Different Functional Forms

Model	Independent Variable RTI	BBR	DIR	PY	TY
λ = -.53	0.1168	1.9396	1.1779	0.2279	0.0092
λ = 0	0.2067	1.4273	0.8345	0.1932	0.0100
λ = 1	0.1110	0.7528	0.1547	0.2273	0.0128

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